WATER FACTS

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U.S. DEPARTMENT OF AGRICULTURE
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NEARLY every community has a water problem. One-fourth the population today is troubled with water shortage, poor water, or both. And the prospects are for even more difficulty in the future.

Why this growing concern over water?

Is there less water than formerly? Or are we simply using more?

Where do we begin to cope with the water problem?

Where does our water come from?

Precipitation (rain, snow, hail, sleet) is the source of our water supply.

The "water cycle"—from clouds in the sky to land and ocean and back to the sky again—constantly renews the water supply.

As water falls upon the ground, some runs off over the surface, some is held in the soil, and some percolates to ground water.

Water in the soil is used to grow crops, pastures, forests, and all the other vegetation that covers the land. In the aggregate, about 70 percent of the national water supply is transpired by plants or evaporates directly from the soil or other surfaces.

Surface runoff and ground water serve direct human needs in homes, industries, irrigation, recreation, etc. Nationwide, about 80 percent comes from surface sources and 20 percent from ground water.

Watersheds divide the supply

The water cycle does not bring the same amount of water to all communities.

Precipitation is not spread evenly over the country. It ranges from 120 inches a year along the Northwest coast to less than 5 inches in the arid Southwest.

Within a region, the water that falls is divided into separate portions by watersheds. A watershed is any area of land that drains into a particular stream or body of water.

Each community depends upon the insoak and runoff of its own watershed. Once on its downhill course, water cannot cross watershed divides, although some ground water may pass beneath watershed boundaries.

Water problems, therefore, are local problems. They arise because the water supply of a watershed does not match the demands of its people and industries.

Some communities, of course, arrange to tap the supplies of other watersheds. But, by and large, problems of water shortage, floods, pollution, or sedimentation must be met within the confines of each watershed.

Land influences water supply

Since lakes and streams occupy less than 2 percent of the country's area, about 98 percent of the precipitation must fall on land surfaces.

Whether the water enters the ground or runs off overland depends largely upon the nature and condition of the soil and its vegetative cover.

Also, the capacity of the soil to store water within reach of plant roots varies with soil type and condition.

What happens to precipitation, therefore, is greatly influenced by the management of watershed lands.

The farmers and ranchers who control our farmlands, rangelands, and woodlands also control to an important degree the movement of the water that falls on their land.

How much water?

There is just so much water. Except for negligible amounts newly created or destroyed by chemical changes, the earth's water supply remains constant.

Average annual precipitation in the United States is about 30 inches. This amounts to about 4,300 billion gallons a day. That is our total water supply.

Total streamflow derived from surface runoff

and ground water amounts to about 8.5 inches a year, or about 1,200 billion gallons a day. That is the potential sustained supply for direct human use. It is more than four times the average daily use now, about two times the predicted requirements in 1980.

Surface water supplies

Streams, lakes, and reservoirs are the major sources of available water. They supply about 70 percent of the water used by cities and towns and by farmers for irrigation, 80 percent of the fresh water used by industry, and nearly all of that used by hydroelectric power.

Land use has greatly changed the flow regimen of many streams. Deforestation, urbanization, bad farming practices, and range abuse increase surface runoff during rains.

Total annual streamflow from large river basins seems to be little changed by land use. But the timing, the size of peak flows, and the part of the streamflow that comes from surface runoff and from ground water may be greatly altered.

These changes aggravate water shortages during dry seasons and flood hazards during wet ones.

Though the amount of water in natural lakes is large in comparison with that in streams, most of it cannot be withdrawn because it is below the outlet.

Reservoirs, on the other hand, have little dead storage. They store floodwater until it is needed for some useful purpose. In 1954 the 1,300 reservoirs larger than 5,000 acre-feet capacity had a combined surface area of more than 11 million acres. These reservoirs could store 278 million acre-feet of water—more than one-fifth of the annual streamflow.

In addition there are countless smaller artificial lakes and ponds. The Soil Conservation Service records show that farmers and ranchers have built more than 1¼ million. Their average size is about two acre-feet.

Ground water

Underground reservoirs contain more fresh water than all surface reservoirs and lakes combined, in-

cluding the Great Lakes. Ground water is estimated to equal 10 years' average rainfall or 35 years' average runoff.

About one-sixth of all the water used in the United States comes from underground sources. Most ground water is part of the water cycle. In many areas ground water is being used faster than it is naturally replenished. In effect, the stored water is being "mined"; water levels in wells are dropping, and the irrigation projects, municipalities, and industries depending on them are threatened.

We are using more water

While the potential supply of water after transpiration and evaporation remains constant, needs for human use pyramid with growing population. Expanding industry and rising standards of living require more water per person to satisfy the American way of life.

From 1900 to 1950, while United States population doubled, total water use, other than for power, increased fourfold. By 1960 it was up another 59 percent from 1950.

Water needs are expected to more than double again by 1980, while population increases 45 percent.

Average daily use for all purposes increased from 600 gallons per capita in 1900 to 1,100 gallons in 1950 and 1,500 in 1960. By 1980 the country will be using 2,300 gallons of water a day for every man, woman, and child.

What we use it for

Industry and irrigation take most of the water withdrawn from primary sources. National estimates for major uses in billions of gallons per day are shown in the table on next page.

It is estimated that only about 25 percent of withdrawn water is "consumed"; i.e., incorporated into a product or evaporated.

About 83 percent of municipal water, 98 percent of industrial water, and 50 percent of rural domestic and irrigation water are returned to surface or underground storage.

Use of water for power is nonconsumptive.

Most nonwithdrawal uses are also nonconsumptive, although there is loss by evaporation from bodies of water provided for these purposes.

	1950	1960	1980	
	Withdrawals [1]	*Withdrawals* [1]	*Withdrawals* [1]	*Percent of 1960*
Public supplies (municipal)	14	21	29	138
Agriculture:				
Rural domestic	3.6	3.6	6	
Irrigation water delivered to farms	79	84	102	
Irrigation water lost in conveyance	([2])	26	59	
Total agriculture	[3] 83	110	167	151
Industry	77	140	363	259
Totals	170	270	559	207

[1] To two significant figures.
[2] Data not available.
[3] Does not include irrigation water lost in conveyance.

Water for cities and towns

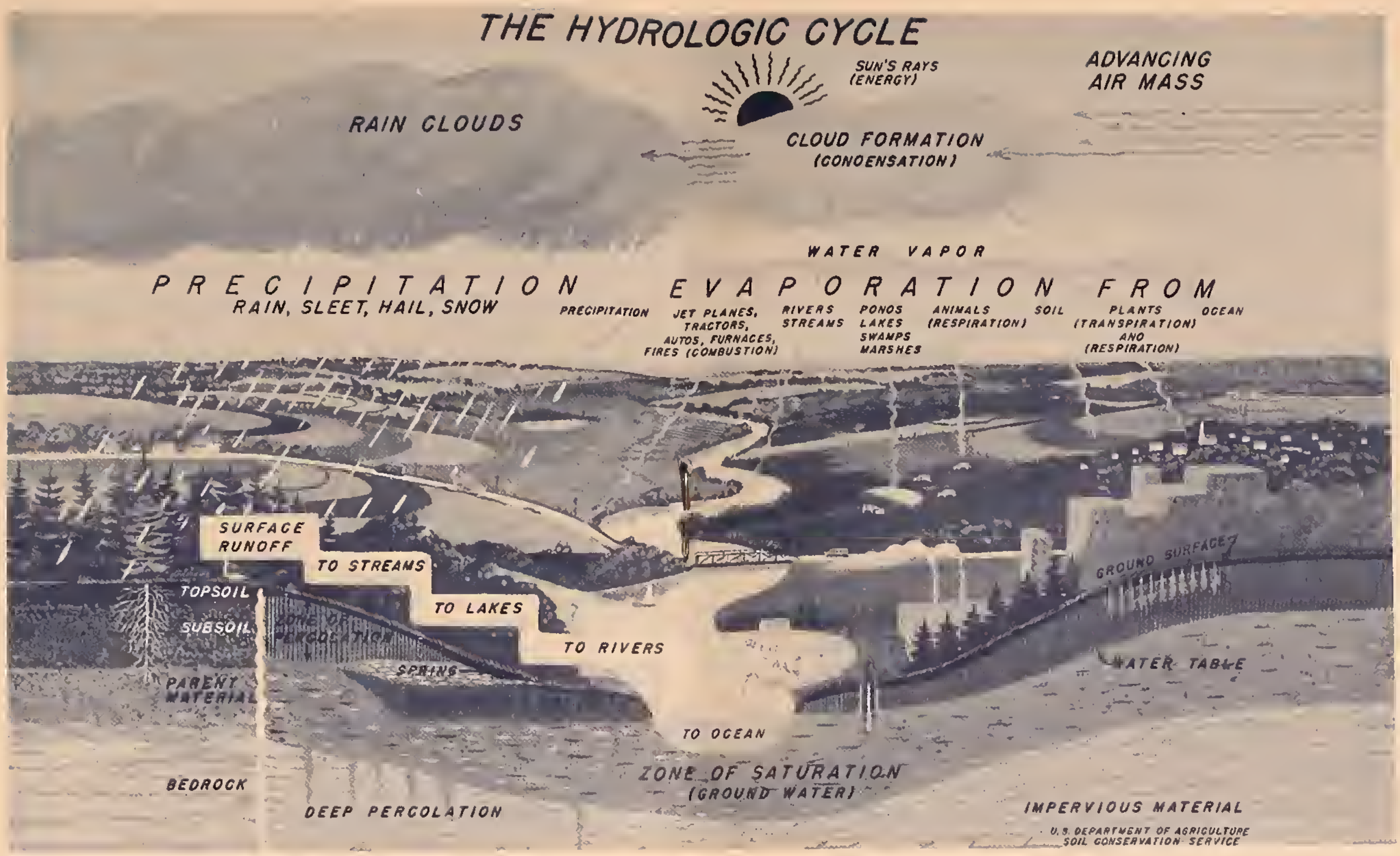
Cities and towns are using more water every year. Average per-capita use has increased from 95 gallons a day in 1900 to 151 gallons in 1960.

Per-capita use varies widely from one community to another. It ranges from 246 gallons of water per person a day in the Great Plains to 116 gallons a day in the Southeast. About 40 percent of the water supplied by municipal systems is used in and about the home; the rest is used by industries and for public services such as firefighting and street washing. The average electrified home uses 40 to 60 gallons of water a day. In the West and Southwest, heavy use of water for lawn sprinkling and air conditioning increases this figure somewhat.

Municipal water systems supplied their customers 14 billion gallons a day in 1950 and 21 billion in 1960. About two-thirds of this water comes from streams and lakes, about one-fourth from ground water.

Water for rural homes and livestock

Rural water comes from private sources. There is no record of the amount used, as for municipal



FROM OCEAN TO SKY TO LAND TO OCEAN

The earth's moisture supply circulates in a gigantic cycle. We think of it as beginning with the waters of the ocean, which cover about three-fourths of the earth's surface. Water from the surface of the ocean is evaporated into the atmosphere. That moisture in turn is eventually condensed and falls back to the earth's surface as rain, hail, snow, or sleet.

Some of the precipitation, after wetting the foliage and ground, runs off over the surface to the streams. It is the water that sometimes causes erosion and is the main contributor to floods.

Of the precipitation that soaks into the ground, some is available for growing plants and for evaporation. Plants use water to manufacture sugar, fats, starches, and cellulose. When these are burned, either in engines, in fires, or in the bodies of animals, the moisture goes back into the atmosphere. Some reaches the deeper zones and slowly percolates through springs and seeps to maintain the streams during dry periods. The streams in turn eventually lead back to the oceans where the water originated.

About 80,000 cubic miles of water are evaporated each year from the oceans. About 15,000 cubic miles are evaporated from the lakes and land surfaces of the continents. Total evaporation is equaled by total precipitation, of which about 24,000 cubic miles fall on land surfaces—equivalent to 475 feet of water over all of Texas.

systems. The quantity can only be estimated from population figures and average requirements.

On this basis, it is estimated that in 1960 rural homes used about 2 billion gallons a day. About 1.9 billion gallons a day was from wells and springs.

Rural domestic water needs are figured at 50 gallons per person per day in homes with running water, and 10 gallons per day for those without. About 36 million of the 48 million rural people live in homes with running water.

Livestock water needs are figured at 20 gallons per animal per day for milk cows; 10 gallons for other cattle, horses, and mules; 3 gallons for hogs; 2 gallons for sheep and goats; and 0.04 to 0.06 gallon for poultry.

Water for irrigation

Irrigation is the Nation's greatest consumptive use of water.

Farmers withdraw for irrigation 4 times as much water as municipalities and 60 percent as much as industries use. About 60 percent of irrigation water is evaporated or transpired by crops. As a result, irrigation probably consumes several times as much water as all other uses combined.

Irrigators used 94 million acre-feet of water on about 37 million acres of crops in 1961. More than 70 percent of this water was from surface sources; about 30 percent from ground water.

This amounted to an average of 84 billion gallons a day although its use was not uniform throughout the year. Crops must be watered primarily during their season of growth, usually only a few months or even weeks.

The seasonal need for irrigation water often puts a strain on local supplies, even where the total quantity would be adequate if its use could be spread over the entire year.

Water for industry

Water is industry's No. 1 raw material. Industrial use of water from private sources in 1950 averaged 77 billion gallons a day. By 1955 it had jumped to 110 billion gallons a day, and by 1960 to 140 billion gallons a day, including the 100 billion gallons a day used for fuel-electric power.

More than 95 percent of industrial water came from surface supplies in 1960, the rest from ground water.

About 65 percent of industrial water was used by steam electric generating plants in 1955, mainly for condensėr cooling. By 1960 this had increased to 71 percent. The rest is used primarily for manufacturing and processing.

Manufacturing uses tremendous volumes of water. For some products as much as 300 pounds of water is required for each pound of finished product.

The amount of water used for any product varies widely, according to the process used, efficiency of the plant, the degree to which water is recirculated, and other factors. Following are general ranges reported by some major industries in 1950:

	Water used, gallons
Steam-generated electricity, per 1,000 kw.-hr.	52,000 to 170,000
Refined petroleum (processed crude), per 1,000 barrels . .	151,000 to 15,000,000
Rayon yarn, per ton.	250,000 to 403,974
Woolen cloth, per 1,000 yards	40,000 to 510,000
Rolled steel, per ton.	6,000 to 110,000
Paper and pulp, per ton.	53,000 to 80,000
Paperboard, per ton	7,692 to 80,000
Cane sugar, per ton	4,000 to 110,000

The trend toward synthetic and more highly refined products, as well as the rapid expansion of industry, calls for increased water supplies.

On the other hand, many plants can reduce their water intake by using other types of cooling systems or by recirculating and reusing water. For example, a carbon black plant in Texas that is air-cooled uses only 0.25 gallon of water per pound of carbon black produced. In contrast, similar plants that are water cooled used 4 to 14 gallons per pound. Other especially low rates of water use reported by individual plants include:

	Water used, gallons
Steam-generated electricity per 1,000 kw.-hr.	1,320
Refined petroleum per 1,000 barrels	800
Finished steel per ton	1,400

The local abundance or scarcity of water and the economics of installing and operating water-conserving equipment largely determine the practices used at each plant.

Water for power

More water is withdrawn from streams and reservoirs to generate power than for all other uses combined. An average of 2,000 billion gallons a day was used for waterpower in 1960, more than 7½ times as much as for all other purposes.

Most of this water is used to generate electricity. Some turns machinery in small mills and factories.

Many new hydroelectric plants are being constructed. Use of water for power increased 36 percent from 1950 to 1955, and 33 percent from 1955 to 1960.

Water used for power is nearly all returned to streams, except amounts which are evaporated from reservoirs, estimated at 9 billion gallons a day in 1954. This is almost half the quantity withdrawn from public supplies in 1960, and 2½ times the quantity consumed.

Water for recreation and wildlife

Water is the key to many kinds of recreation. It is indispensable to wildlife, which itself is valuable to recreation.

Water is neither withdrawn nor consumed when used for recreation or wildlife habitat. Other uses, such as irrigation and industry, often reduce the supply or diminish the value of water for recreation and wildlife.

In the United States there are more than 74 million acres of wet areas—marshes, sloughs, meadows, ponds, etc.—that are of value to waterfowl. Water losses from such wet areas are largely the result of evaporation, seepage, and drainage.

The supply and use of water for recreation and wildlife cannot be measured in gallons, as for withdrawal uses. Rather, the availability and character of lakes, streams, and other bodies of water to meet the needs in each location are the crucial matters.

Both financial and technical assistance are now available to local groups in developing watershed recreation. This includes enlarging dams to form larger bodies of water, building new reservoirs for recreation use, improving natural lakes, streams, or shorelines, and providing recreation facilities bordering the water. There is increasing public demand for new water-based recreation facilities.

Fish, waterfowl, and many other kinds of wildlife require suitable aquatic habitats for propagation and survival.

Some other uses

Transportation of bulk freight by water is important to many industries and cities. About 115 billion ton-miles of commercial traffic move annually on inland waterways.

Streams also serve a valuable function in waste disposal. Within limits they can purify and carry away some wastes. Growing cities and industries, however, have overloaded many streams with sewage and other wastes and created serious pollution of water supplies.

Water losses

Local water shortages arise in part from losses that keep some of the potential supply from being put to beneficial use.

Flash runoff robs communities of part of their natural water resources. Peak flows that exceed storage facilities are an economic loss, aside from the damage they do as floods.

Sedimentation that reduces storage capacity, evaporation that dissipates stored water, and pollution that makes water unfit for certain uses all reduce the usable supply.

Sedimentation.—Sediment carried into ponds and reservoirs by flowing water gradually fills their storage basins. In 1963 the average loss to the Nation's reservoirs was estimated at 850,000 acre-feet annually.

Reservoirs lose most of their value when they are 50 to 60 percent silted. Their useful life, therefore, may be as little as 15 or 20 years where sedimentation rates are highest and storage capacity is small, as with farm ponds receiving runoff from unprotected cultivated land.

Sediment also fills harbors, canals, and rivers, where it interferes with navigation and detracts from their value for recreation and fish life.

Sedimentation is most serious in watersheds with much unprotected land where erosion is active.

Work plans being developed by the SCS for 157 watersheds covering 9.7 million acres show that 73 percent of the sediment is derived from sheet erosion, 10 percent from gully erosion, and

17 percent from other sources such as roadside erosion, streambank erosion, and flood-plain scour. The rate of erosion, before conservation treatments had been applied, amounted to about 78 million tons of sediment a year. The watershed projects, when completed, will reduce the erosion by about one-half.

Pollution.—Pollution of streams, lakes, and coastal waters with sewage and other wastes from cities and industries reduces the supply of water suitable for many uses.

Sewage flow and discharge was estimated at 16.7 billion gallons a day in 1954.

Municipal sewage is composed of domestic, commercial, and public wastes, and industrial wastes discharged through municipal systems. In 1960 about 80 percent of industrial establishments were connected to municipal systems.

New types of wastes that cause new water problems are synthetic organic chemicals, radioactive substances, newly identified viruses, and disease-producing organisms. Also, detergents, pesticides, and herbicides that reach streams and underground waters from land surfaces present problems requiring a vast amount of research to determine control methods.

Thus, although cities and industries return nearly 90 percent of the water they use to natural sources, some of the water may be largely worthless for reuse.

Problems of too much water

Too much water at the wrong time may be as serious as too little.

Hardly a year goes by without a disastrous flood somewhere in the United States.

The average annual damage from floods in the United States is about $1 billion. About 56 percent of this occurs on the upstream tributaries and 44 percent in the downstream valleys.

Most of the damage on the headwater streams—about 70 percent—is agricultural.

Most of the downstream flood damage is to residences, industrial and business property, and transportation and utility facilities. Even so, about a third of the damage in large valleys is to rich agricultural land of the flood plains.

Floods can be reduced by soil and water conservation on the farmlands, forests, and ranges that

make up the watersheds and by water-control structures on the upstream channels.

Floods can be further controlled by large downstream dams, dikes, and other structures to protect cities, towns, and urban property, and agricultural land on the downstream flood plains.

Both upstream and downstream measures are encouraged by the Federal Government.

Drainage.—Drainage of wet land has been a necessary step in much of the settlement and agricultural development of America.

Nearly a fourth, or about 216 million acres, of the Nation's potential agricultural land was originally too wet for farming.

Only about half of the land drained for agriculture was actually covered with water most of the time before drainage. Rather, the soils were waterlogged or occasionally dotted with transitory pools that interfered with cropping.

At present the total farm drainage problem of mainland United States includes about 172 million acres. Community-wide projects are needed in a total of 3,931 watersheds to remove water from 45 million acres of cropland. Some 549,000 farms would benefit by these projects.

Control of water is the dominant conservation problem on 11 million acres of pasture. Of high priority is the drainage of at least 4 million acres of cropland in irrigated projects. Such projects are developed at high cost, and excess water contributes to salinity and alkali problems which may destroy the usefulness of the land for a generation.

Removal of water from farmland needing drainage is primarily a matter of farm efficiency. Therefore, if naturally wet soils are to remain in cultivation they must be drained so that the farm can be operated as an economic unit.

New drainage work needs to be carefully planned within the known capability of the land. Wildlife and recreation values also need to be safeguarded.

Watershed protection and conservation

Water problems in the last analysis are watershed problems.

It is within separate watersheds that communities can manage their water resources to best meet their own needs.

This takes teamwork. All the people must plan and act together to make the best use of all the land and water resources. Water control and

conservation cannot be separated from soil conservation.

Rural and urban interests all over the country are joining in small watershed-protection and flood-prevention projects that deal with all aspects of land and water conservation.

Local, State, and Federal agencies cooperate in planning, financing, and carrying out projects under the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Cong., as amended). More than 2,000 groups of citizens have applied for Federal financial and technical assistance in planning and carrying out watershed projects.

These projects combine soil and water conservation on the land with control and use of runoff by means of upstream structures in small watersheds. Improvements for industrial and municipal water supplies or wildlife and recreation facilities can be included at local expense.

Small watershed projects are initiated by local organizations, such as soil conservation districts, municipalities, counties, or watershed associations.

The Soil Conservation Service has administrative leadership for the Department of Agriculture's part in these projects.

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